A Key to the Chaetognatha of the Tropical Eastern Pacific Ocean

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The Inter-American Tropical Tuna Commission recently commenced a study of zooplankton collections from the tropical eastern Pacific Ocean to investigate the occurrence of planktonic organisms that can be used as biological indicators of water masses. This study is a part of the Commission's broader investigations of the relationship of the yellowfin and skipjack tunas and their food supply to the hydrographic regime within the eastern Pacific area.

The eastern tropical Pacific Ocean has been recently defined by Wooster and Cromwell (1958) as "the region lying between the Tropic of Cancer (23°27'N.) and the Tropic of Capricorn (23°27'S.) and extending westward from the coast of Central and South America to 130° W."

Two groups of animals which include species of known indicator value were selected for particular attention. These are the Euphausiacea and the Chaetognatha. The identities of the euphausiids were readily determined using the keys in the recent work of Boden, Johnson, and Brinton (1955). At the outset of our studies, the Chaetognatha proved to be quite difficult to identify because the published keys (e.g., Ritter-Zahony, 1911; Michael, 1908, 1911; Thomson, 1947) used characters that are often indistinguishable or whose determination is so time consuming that their use in studies of this sort was found impractical.

For these reasons it was decided to formulate a new key (of the type published by Fraser, 1952, for the chaetognaths of northern waters) that would allow rapid, but accurate, identification of a given specimen by using characters that are readily distinguishable in preserved animals of good-to-fair condition. General discussions of the characters and their use for purposes of identification are presented by Fowler (1904, 1906) and Michael (1908).

ACKNOWLEDGMENTS

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METHODS AND MATERIALS

The material was selected from the zooplankton collections made by University of California Scripps Institution of Oceanography research vessels during Eastropic Expedition, 1955. Figure 1 shows the locations of zooplankton stations from which the material for this study was taken. Holmes, Schaefer, and Shimada (1957) have outlined the methods and equipment employed in making these collections.

Specimens in good condition were identified and isolated from the Eastropic zooplankton. Upon accumulation of a number of these, the measurements and counts necessary to complete the armature formulae were made. All measurements were made with a calibrated ocular micrometer. These are presented in tabular form in the text, together with similar data obtained from specimens of known identity from eastern and central Pacific waters. The latter specimens were kindly donated to the writer by Dr. T. Tokioka of the Seto Marine Biological Laboratory, Japan; and Mr. T. Hida of Pacific Oceanic Fishery Investigations, U. S. Fish and Wildlife Serv-

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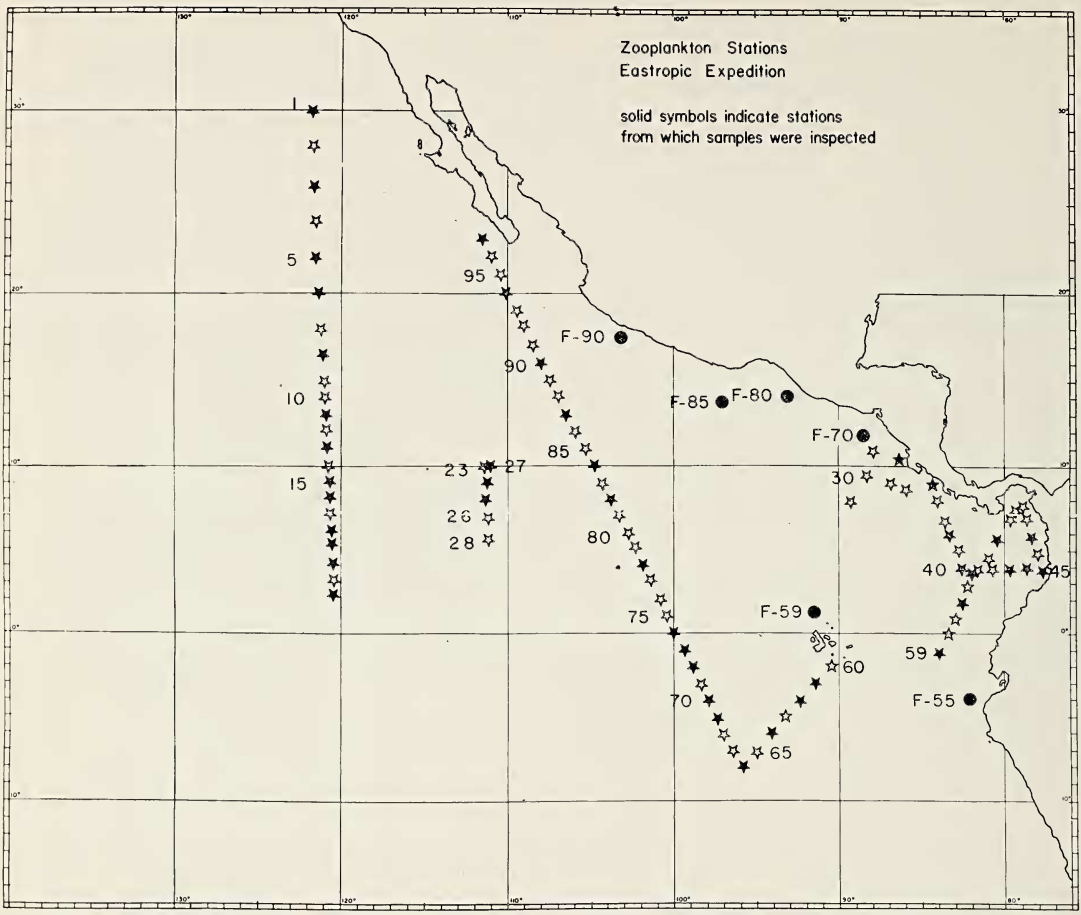


FIG. 1. Zooplankton stations occupied on Eastropic Expedition. Stars indicate stations occupied by RV Horizon; circles indicate those occupied by RV Spencer F. Baird. Modified from Holmes, Schaefer, and Shimada (1957).

ice, Honolulu, T. H. Of these, only those species represented in the Eastropic collections are considered in this publication. The armature formulae are included in this paper as they have been found useful in determining the variability within the limits of each species and in verifying the identity of juvenile and damaged specimens. For the measurements of the total length of the body and the tail segment, the caudal fin has been excluded as it is often damaged and its inclusion would lead to error.

DESCRIPTION OF THE SPECIES FOUND IN EASTROPIC COLLECTIONS

Several oceanographic investigations of the eastern Pacific have been made (Albatross, Dana, Discovery, and Shellback expeditions), but published works considering the Chaetognatha from the area are very few. Of the 36 species considered valid by Tokioka (1952), the following 18 species have been recorded by Baldasseroni (1915), Michael (1908, 1911), and Bieri (1957): *Sagitta bedoti*, *S. bipunctata = californica*, *S. decipiens*, *S. enflata*, *S. ferox*, *S. hexaptera*, *S. lyra*, *S. minima*, *S. neglecta*, *S. pulchra*, *S. regularis*, *S. robusta*, *S. serratodentata*, *S. tenuis*, *Krohnitta pacifica*, *K. subtilis*, *Eukrohnia hamata*, and *Pterosagitta draco*.

In addition to these species, *S. serratodentata pacifica* and *S. pseudoserratodentata* have been identified from the Eastropic material.

Sagitta bedoti Béraneck

S. bedoti, Bieri, 1957

Body firm, moderately opaque. Tail segment 17–27 per cent of total length of animal; hooks 6–7; anterior teeth 10–13; posterior teeth 20–29, or more. Anterior fins long, tapered, starting at ventral ganglion. Posterior and caudal fins close to, or touching, the seminal vesicles. Seminal vesicles oval. Intestinal diverticula absent. Collarette obvious.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
12.0	22.5	7	12	29
11.0	23.6	6	13	27
10.5	21.9	7	11	25
9.9	21.2	7	10	24
8.3	26.5	7	11	27
7.4	22.9	7	10	20
Tokioka's specimens:				
10.4	23.2	6	11	28
9.5	21.1	7	12	28
8.5	17.7	6	10	23
7.9	24.0	7	10	22

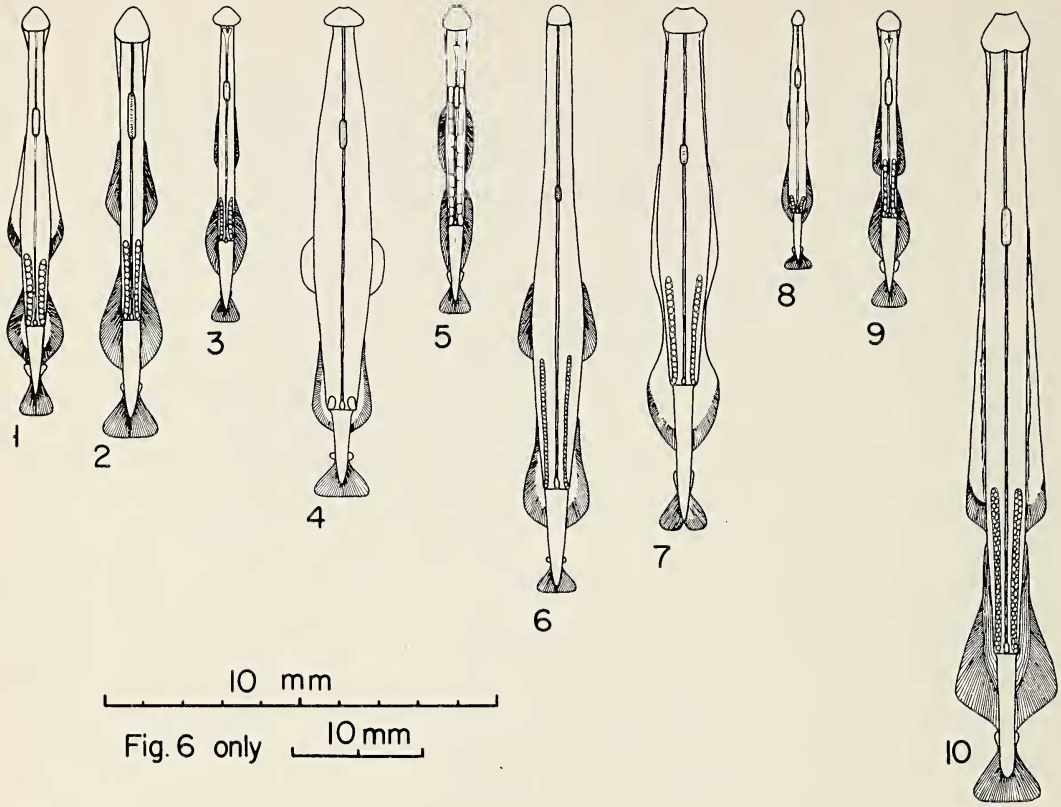
Sagitta bipunctata Quoy et Gaimard = S. californica Michael

S. bipunctata Michael, 1911
S. californica, Bieri, 1957

Bieri (1957) presents arguments supporting the change of the name of the species referred to by several workers as *S. bipunctata* to *S. californica*. Until this point is satisfactorily settled, I prefer to use the older name, *S. bipunctata;* but also to record that here, these two terms refer to the same single species.

Body firm, moderately opaque. Tail segment 21–28 per cent of total body length; hooks 5–10; anterior teeth 4–7; posterior teeth 8–14. Anterior fins start at posterior end of ventral ganglion. Posterior fins do not reach seminal vesicles; wider and slightly longer than anterior fins, widest behind tail-septum. Caudal fin joins seminal vesicles. Collarette present. No intestinal diverticula.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
16.3	27.6	8	4	8
11.0	24.5	10	7	14
9.3	21.5–24.7	5–9	4–5	9–12



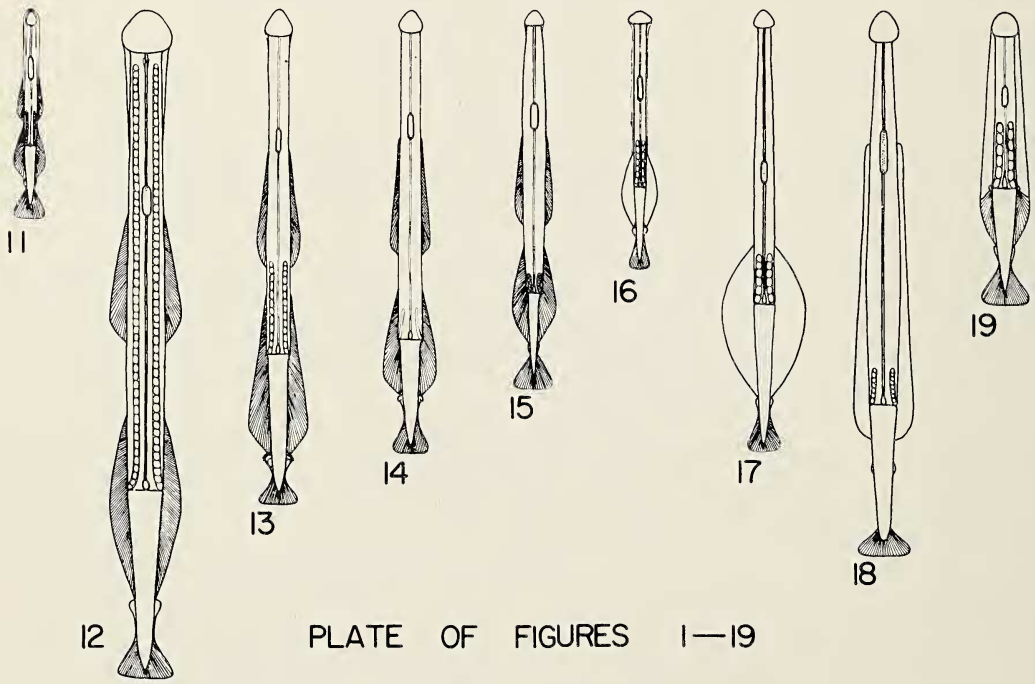


PLATE OF FIGURES 1—19

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
8.0	26.3	8	4	9
6.4	23.0	8	5	10
Tokioka's specimen:				
11.7	21.4	8	7	13
Hida's specimens:				
11.7	25.6	7	4	10
11.5	25.2	6	5	11
11.1	25.2	6	5	11
10.7	23.5–27.1	7–8	4–6	9

Sagitta decipiens Fowler, 1905

S. decipiens, Michael, 1908

Body delicate, moderately opaque. Tail segment 22–27 per cent of body length; hooks 5–7; anterior teeth 7–10; posterior teeth 13–20. Anterior fins start just posterior to ventral ganglion. Posterior fins widest at level of tail-septum, lying mostly on body segment, not reaching seminal vesicles. Caudal fin touching seminal vesicles. Intestinal diverticula present. Collarette absent.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
11.0	23.0	5	9–10	17
10.0	23.0	6	8	17
9.2	25.0	5	7	17
8.8	22.7–23.8	6–7	8–9	13–20
8.6	26.7	6	9	16

EXPLANATION OF PLATE I

(All figures drawn from preserved material, some with the aid of photographs; semidiagrammatic.)

FIG. 1. *S. bedoti*, 10.0 mm. specimen.
FIG. 2. *S. bipunctata*, 10.6 mm. specimen.
FIG. 3. *S. decipiens*, 7.8 mm. specimen.
FIG. 4. *S. enflata*, 12.6 mm. specimen.
FIG. 5. *S. ferox*, 7.6 mm. specimen.
FIG. 6. *S. hexaptera*, 44.9 mm. specimen. (Note change of scale.)
FIG. 7. *S. lyra*, 13.2 mm. specimen.
FIG. 8. *S. minima*, 6.5 mm. specimen.
FIG. 9. *S. neglecta*, 7.3 mm. specimen.
FIG. 10. *S. pulchra*, 19.7 mm. specimen.
FIG. 11. *S. regularis*, 5.1 mm. specimen.
FIG. 12. *S. robusta*, 17.0 mm. specimen.
FIG. 13. *S. serratodentata pacifica*, 12.5 mm. specimen.
FIG. 14. *S. pseudoserratodentata*, 11.2 mm. specimen.
FIG. 15. *S. tenuis*, 9.5 mm. specimen.
FIG. 16. *K. pacifica*, 6.5 mm. specimen.
FIG. 17. *K. subtilis*, 11.2 mm. specimen.
FIG. 18. *E. hamata*, 13.6 mm. specimen.
FIG. 19. *P. draco*, 7.2 mm. specimen.

Sagitta enflata Grassi, 1883

S. enflata, Michael, 1908, 1911; Bieri, 1957
S. inflata, Baldasseroni, 1915

Body flaccid, transparent, with marked constriction at the tail-septum. Tail segment 14–18 per cent of total length; hooks 8–9; anterior teeth 4–10; posterior teeth 7–15. Anterior fins rounded, removed from ventral ganglion by a distance greater than the length of the fin, narrower than posterior fins. Posterior fins do not touch seminal vesicles, widest at level of tail-septum, or a little anterior. Caudal fin joining seminal vesicles. No collarette. No intestinal diverticula. Seminal vesicles round. Ovaries short.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
11.8	16.1	8–9	9–10	13
11.3	16.5	9	7	13
10.1	15.7	8	6	10
10.0	14.0	9	7	11
6.0	16.3	9	4	7
Hida's specimens:				
15.6	17.9	9	10	12
15.4	15.6	9	10	15
14.3	16.1	9	6	12
12.6	15.1	9	6	13
12.0	15.0	9	7	11

Sagitta ferox Doncaster, 1903

S. ferox, Bieri, 1957

Body firm, opaque, short and robust, of equal width for most of the length of body segment. Tail segment 22–28 per cent of total length; hooks 6–7; anterior teeth 6–13; posterior teeth 4–12. Anterior fins reach the posterior end of ventral ganglion. Posterior fins and tail fin close to, or touching, seminal vesicles. Posterior fins longer than anterior fins. Collarette present. Intestinal diverticula present; often removed from neck. Seminal vesicles angular, with anterior edge slanting postero-laterally. Ovaries when ripe containing cuboidal ova that fill body cavity.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
9.0	24.4	6	10	8
8.4	26.2	7	8	10
8.2	24.4	7	12	9
7.8	24.4	7	8	12

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
7.2	26.4	7	8	10
7.1	25.4	7	7–8	11
7.0	25.7	7	6–7	9
6.8	26.4	7	6	9
Tokioka's specimens:				
7.8	24.3	7	8	11
7.5	22.7–25.2	7	13	10
7.3	27.4	7	10	..
7.2	26.5	7	13	11
7.0	25.8	7	6	4

Sagitta hexaptera d'Orbigny, 1834

S. hexaptera, Michael, 1908, 1911; Baldasseroni, 1915; Bieri, 1957

Body large, transparent. Tail segment 15–22 per cent of total length of body; hooks 4–8; 1–4 anterior teeth; posterior teeth 1–4. Anterior fins widely separated from ventral ganglion; narrow and rounded. Posterior fins not joining seminal vesicles. Caudal fin close to, but not joining, seminal vesicles. Ovaries narrow, containing round ova, extending to posterior end of anterior fin when mature.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
44.5	15.7	6	3	..
23.7	17.8	7	3	4
19.0	19.0	7	3	4
Tokioka's specimens:				
34.8	19.8	4	3	2
34.6	18.8	2 (?)	1	1
23.5	21.3	6	3	1
22.3	19.3	7	4	2
14.3	20.9	7	3	3
Hida's specimens:				
36.5	18.4	8	2	3
31.4	18.8	6	2	3

Sagitta lyra Krohn, 1853

S. lyra, Michael, 1911; Baldasseroni, 1915; Bieri, 1957

Body large, flaccid, opaque. Tail segment 10–19 per cent of total length; hooks 6–10; anterior teeth 4–5; posterior teeth 2–9. Anterior fins reaching ventral ganglion, or further anterior; connected to the posterior fins by a "fin-bridge." Posterior fins close to, or touching, seminal vesicles. Caudal fin separated from seminal vesicles. Intestinal diverticula absent.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
29.1	10.3	9	5	6
29.0	13.1	10	5	7
25.8	14.7	10	5	9
25.0	14.8	10	4	6
21.2	16.5	9	5	7
19.8	17.7	10	..	..
16.0	17.8–18.8	10	4	6
Hida's specimens:				
41.5	12.1	6	4	5
40.0	13.3	8	5	2

Sagitta minima Grassi, 1881

S. minima, Bieri, 1957

Body small, transparent, with marked constriction at the tail-septum. Tail segment 16–24 per cent of total length; hooks 5–8; anterior teeth 2–5; posterior teeth 3–11. Anterior fins not rayed, narrow, tapered, but rounded; removed from ventral ganglion. Posterior fins not reaching seminal vesicles. Caudal fin connected to seminal vesicles. No intestinal diverticula. Ovaries short; when mature, they appear to contain 3–5 large, round ova.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
6.6	18.3	7	4	10
5.8	21.6	7	4	8
5.6	20.7	7	4	11
5.5	18.2–23.6	7–8	3–4	9–11
5.4	19.4–23.6	7–8	4	9–11
5.3	21.7	8	4	11
5.1	23.5	8	5	10–11
4.9	23.7	7	2	9
4.6	23.9	8	5	10–11
Tokioka's specimens:				
7.1	16.9	5	3	4
6.3	20.6	6	3	6

Tokioka's specimens:				
6.1	19.7	6	..	6
5.8	18.9	5	5	9
4.4	22.7	5	..	3

Sagitta neglecta Aida

S. neglecta, Michael, 1908; Baldasseroni, 1915; Bieri, 1957

Body firm, semiopaque. Tail segment 27–31 per cent of total length; hooks 6–8; anterior teeth 5–7; posterior teeth 13–17. Anterior fins start at ventral ganglion. Posterior fins reach seminal vesicles. Caudal fin separated from seminal vesicles by a distance equal to about ½ length of seminal vesicles. Seminal vesicles rounded. Ovaries containing rounded ova, extending anterior to posterior border of anterior fins. Collarette present. Intestinal diverticula present.

Few specimens of *S. neglecta* were found in the Eastropic material; only one of these was in such condition that a complete formula could be obtained.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimen:				
7.3	27.4	7	5	17

Sagitta pulchra Doncaster, 1902

S. pulchra, Michael, 1908; Baldasseroni, 1915; Bieri, 1957

Body firm, moderately opaque; usually slim, but can be robust and quite transparent; with a marked constriction often present at tail-septum as seen from side. Tail segment 16–24 per cent of total length; hooks 6; anterior teeth 5–9; posterior teeth 8–12. Anterior fins tapered, reaching posterior end of ventral ganglion. Posterior fins shortly separated from seminal vesicles; widest posterior to the tail-septum. Caudal fin joining seminal vesicles. Collarette present, readily visible. Intestinal diverticula absent. Seminal vesicles shaped as ovals; ovaries with small, round ova.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
20.3	16.3	6	7	12
20.0	16.5	6	7	9
19.5	16.4	6	9	11
16.7	18.0	6	8	10
14.9	17.5	6	7	9
13.9	18.7	6	6	11
10.1	19.8	6	7	10

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Tokioka's specimens:				
15.8	17.1	6	5	10
15.6	23.1	6	. .	8
14.3	16.1	6	7	10
12.9	18.6	6	6	11
9.4	20.2	6	6	10
9.3	22.6	6	6	9
7.8	23.1	6	6	10

Sagitta regularis Aida, 1897

S. regularis, Bieri, 1957

Body firm, moderately opaque. Tail segment 29–34 per cent of total length; hooks 7–8; anterior teeth 2–4; posterior teeth 4–7. Anterior fins start at posterior end of ventral ganglion. Small interval between anterior and posterior fins. Posterior fins wider than anterior fins. Voluminous collarette usually present, covering head and most of body. No intestinal diverticula.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
5.8	32.8	7	3	5
5.6	32.1	8	4	6
5.3	32.1	8	3	5
5.2	30.8–32.7	7	3–4	4–6
5.1	31.4	8	4	7
5.0	32.0–34.0	7	2–4	4–5
4.8	29.2–31.3	7–8	3	5

Sagitta robusta Doncaster, 1903

S. robusta, Baldasseroni, 1915; Bieri, 1957

Body very opaque, firm; of uniform width from neck to tail-septum. Tail segment 24–28 per cent of total length; hooks 5–7; anterior teeth 6–11; posterior teeth 8–15. Anterior fins start at posterior end of ventral ganglion. Posterior and caudal fins both reaching seminal vesicles. Seminal vesicles long-tapered posteriorly. Ovaries long (when fully mature they may extend to the neck), containing eggs of moderate size. Intestinal diverticula present, but specimens are often too opaque for them to be seen.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
13.7	25.6	7	8	8

Eastropic specimens:				
13.6	28.0	6–7	7	12
13.2	27.3	7	10	14
12.7	26.0	5–7	10–11	14–15
12.5	25.6	6–7	10	13
9.5	26.3	6	9	12–13
9.3	28.0	7	6–7	10
8.6	25.6	6	11	12
Tokioka's specimen:				
16.4	26.6	6	8	8
Hida's specimens:				
13.0	26.9	6	9	14
11.9	24.4	7	10	12
11.1	27.0	6	8	13
10.0	27.0	7	8	12

Sagitta serratodentata pacifica Tokioka, 1940

S. pacifica, Bieri, 1957

The nomenclature employed for the *S. serratodentata* group is that suggested by Tokioka (1952). The synonyma are discussed by Furnestin (1953).

Body firm, opaque. Tail segment 22–25 per cent of total length; hooks 5–7; anterior teeth 5–11; posterior teeth 8–24. Anterior fins tapering, narrower than posterior fins; extending anteriorly to posterior end of ventral ganglion. Posterior fins widest behind tail-septum; close to, or touching seminal vesicles. Seminal vesicles greatly expanded anteriorly, armed laterally with 3–10 chitinous spines. Ovaries containing large cuboidal ova. Collarette small, or absent. Intestinal diverticula absent.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
12.5	23.2	6	10	17
12.4	22.5	6	11	23
11.4	22.0	6	10	19
10.8	24.0	5	8	19
10.6	23.5	6	9	20
10.5	22.9	. .	8	15
10.0	25.0	6	7	15
9.6	20.8	7	8	13
Tokioka's specimens:				
13.0	23.5	5	7	13
12.4	23.4	5	9	18
12.2	23.0	7	9	18
12.0	24.2	6	9	17

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Tokioka's specimens:				
11.3	24.8	6	9	18
11.1	23.4	5	7	12–13
10.5	23.9	6	9	16
9.0	23.4	6	6	9
8.9	24.8	7	7	13
8.0	22.5	6	5	8
Hida's specimens:				
12.3	22.8	5	9	16
11.5	23.0	6	. .	24
11.2	23.1	7	8	19
11.1	24.3	5	10	20
10.5	24.7	7	8	14

Sagitta pseudoserratodentata Tokioka, 1939

Tail segment 26–28 per cent of total length; hooks 6–7; anterior teeth 5–6; posterior teeth 7–12.

The features of this species are similar to those of *S. s. pacifica*, except that the seminal vesicles are unarmed, and the anterior edge of the vesicles slopes posterolaterally to a rounded point, from which the longer posterior border extends backwards and medially to rejoin the body wall. The percentage of the total length that the tail segment occupies is greater for specimens of equal size in *S. pseudoserratodentata* than in *S. s. pacifica*, and the number of teeth is less than in *S. s. pacifica* (see armature formulae tables).

S. pseudoserratodentata seems to be mature at a shorter total length than *S. s. pacifica*.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
7.1	26.7	6	5	9
6.8	26.5	7	5	7
6.2	27.4	6	6	12

Sagitta tenuis = friderici

S. tenuis Conant, 1896
S. friderici Ritter-Zahony, 1903
S. tenuis, Bieri, 1957

Body firm, translucent. Tail segment 21–26 per cent of total length; hooks 5–8; anterior teeth 2–5; posterior teeth 4–9. Anterior fins close to, but not reaching posterior end of ventral ganglion. Posterior fins close to, or touching seminal vesicles. Caudal fin reaching seminal

vesicles. Ovaries similar in appearance to those of *S. enflata*. Collarette present but extremely small; often missing in damaged specimens. Intestinal diverticula absent. Teeth wide-based, tapering sharply to a point; tips widely separated.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Tokioka's specimens:				
10.3	22.8	8	5	9
9.4	21.6	8	4	9
7.3	20.6	8	..	..
4.7	23.7	6	3	4
3.9	25.6	5	2	4

The formulae for *S. tenuis=friderici* identified from the Eastropic material have been omitted because the specimens were in such poor condition that accurate measurements could not be made. The specimens for which the formulae are given above were labelled by Tokioka as *S. friderici*. The status of the two species is still doubtful, especially concerning specimens from Pacific waters (Tokioka, 1955). The specimens so far identified from the Eastropic material were immature and in poor condition and provide no basis for a discussion of the validity of this species at this time. Bieri (1957) gives the impression that the two are synonymous, but his final interpretations must await the publication of his findings.

Krohnitta pacifica Aida, 1897

K. pacifica, Bieri, 1957

Body moderately firm, translucent-to-opaque. Single pair of lateral fins long and tapering; fins extend anteriorly from seminal vesicles over posterior ⅓ of trunk; widest behind septum. Collarette present, extending as narrow band from neck to anterior edge of fins. Tail segment 28–38 per cent of total length; hooks 6–9; teeth 7–15. Lateral and caudal fins joining seminal vesicles. Ovaries with cuboidal ova. Intestinal diverticula absent.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	TEETH
Eastropic specimens:			
7.2	31.9	7	11
6.8	33.8	7	13
6.6	31.8–31.9	7	13
6.4	35.9–37.5	7	14–15
6.3	30.1	7	12
Tokioka's specimens:			
7.1	28.1	9	12
7.0	28.6	9	12
4.2	31.0	6	7–8

Krohnitta subtilis Grassi, 1883

Eukrohnia subtilis, Michael, 1908, 1911

Body long, thin, moderately transparent, delicate. Tail segment 30–34 per cent of total length; hooks 5–8; teeth 8–12. Lateral fins wide, rounded, often subcircular; extending from seminal vesicles over posterior ⅓ of trunk; widest at level of tail-septum. Collarette and intestinal diverticula absent. Caudal fin touching seminal vesicles. Ovaries with rounded ova.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	TEETH
Eastropic specimens:			
12.5	32.0	7	11
10.2	31.3	7	11
10.0	30.0	8	12
Tokioka's specimens:			
11.3	34.1	6	8
10.6	32.0	6	9
10.2	32.4	5	9
9.1	34.0	6	..
Hida's specimens:			
10.9	30.0–32.0	7	9
10.4	31.2	7	11
9.2	30.5–31.2	7	11

Eukrohnia hamata Möbius, 1875

E. hamata, Michael, 1908, 1911

Body flaccid, opaque, wide. Single pair of lateral fins extending from behind tail-septum to ventral ganglion, not reaching seminal vesicles. Tail-septum 20–26 per cent of total length; hooks 8–9; single row of teeth, 6–17 in number. Tips of hooks curved inward. Intestinal diverticula absent. Collarette absent.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	TEETH
Eastropic specimens:			
10.7	23.4	8	17
7.0	22.9	8	6
Hida's specimens:			
13.9	21.5	9	10
13.7	25.5	9	9
13.2	20.5	9	6
10.7	23.4	9	6

Pterosagitta draco Krohn, 1853

Spadella draco, Michael, 1908, 1911
P. draco, Baldasseroni, 1915; Bieri, 1957

Body opaque, firm. Tail segment 32–38 per cent of total length; hooks 8–9; anterior teeth

4–9; posterior teeth 8–17. Single pair of lateral fins restricted to tail segment; wide, with rounded lateral borders; reaching seminal vesicles. Caudal fin close to, but not touching, seminal vesicles. No intestinal diverticula. Collarette voluminous, all or part frequently missing, extending from head to anterior border of fins, confluent with fins.

BODY LENGTH IN MM.	LENGTH OF TAIL SEGMENT (IN °/₀ OF TOTAL BODY LENGTH)	HOOKS	ANTERIOR TEETH	POSTERIOR TEETH
Eastropic specimens:				
7.1	35.2	8	6–7	12
5.8	36.2	8	6	15
5.6	37.8	9	6	15
5.1	37.2	9	6	17
4.9	32.6	8	5	13
4.4	38.6	9	6	8
4.0	35.0	9	4	..
Hida's specimens:				
7.6	34.2	9	9	15
6.9	34.7	9	9	17
6.8	35.2	9	7–8	11–14
6.3	36.6	9	7	..
6.2	37.0	9	7	17

KEY TO THE PLANKTONIC GENERA AND SPECIES OF CHAETOGNATHA PRESENT IN THE EASTERN TROPICAL PACIFIC

Key to the Genera of Chaetognatha

1. A single pair of lateral fins 2
1. Two pairs of lateral fins, which are sometimes connected ..... **Sagitta**
2. Two rows of teeth; one pair of lateral fins restricted to the tail segment, appearing as a continuation of a voluminous collarette (one species only: *P. draco*) ..... **Pterosagitta**
2. One row of teeth; one pair of lateral fins extending over the trunk and tail segments ... 3
3. Single pair of lateral fins extending from seminal vesicles over the posterior ⅓ of the trunk segment. Teeth long, tapered, tips converging ..... **Krohnitta**
3. Lateral fins slender, not reaching seminal vesicles, extending anteriorly to ventral ganglion. Teeth short, not converging (one species only: *E. hamata*) ..... **Eukrohnia**

Key to the Genus Krohnitta

1. Body slender, transparent; fins very wide, rounded, widest at level of tail-septum; short ovary with rounded ova; collarette absent ..... **subtilis**
2. Body robust, opaque; fins not rounded, widest behind tail-septum; ovaries contain large cuboidal ova; collarette sometimes evident as a narrow band of epidermal thickening extending from neck to anterior edge of fins ..... **pacifica**

Key to the Genus Sagitta

1. Anterior fins start some distance posterior to ventral ganglion 2

1. Anterior fins start at level of posterior end of ventral ganglion, or farther anterior.....7
2. Lateral fins joined by "fin bridge"; caudal fin bilobed.....**lyra**
2. Lateral fins not joined.....3
3. Anterior fins rounded, widely separated from ventral ganglion.....4
3. Anterior fins tapering; distance between anterior fins and ventral ganglion not great (distance is less than that equal to a length of the ventral ganglion).....5
4. Teeth numerous; hooks 8–10; small-to-middle size species.....**enflata**
4. Teeth few, protruding; large species.....**hexaptera**
5. Moderately opaque species; delicate, of medium length; intestinal diverticula present.....**decipiens**
5. Small, transparent species; no intestinal diverticula.....6
6. Tail segment tapers sharply posterior to tail-septum, marked constriction at septum; 3–5 large, round ova in mature specimens; lateral septa connecting gut to body wall sometimes evident; posterior fins widely separated from seminal vesicles.....**minima**
6. Constriction at tail-septum not great; ovaries club-shaped; posterior fins close to, but not touching, seminal vesicles; caudal fins touching seminal vesicles..**tenuis=friderici**
7. Posterior fins joining, or close to seminal vesicles.....8
7. Posterior fins not joining seminal vesicles; no intestinal diverticula; seminal vesicles head-shaped anteriorly; 9–10 hooks.....**bipunctata**
8. Voluminous collarette covering head and most of body.....**regularis**
8. Collarette not covering head.....9
9. Posterior teeth less than 20; intestinal diverticula may, or may not be present.....10
9. Posterior teeth 20–30; intestinal diverticula absent; anterior fins tapering, reaching ventral ganglion; collarette obvious.....**bedoti**
10. Intestinal diverticula absent.....11
10. Intestinal diverticula present.....13
11. Posterior fins shorter than anterior fins; widest behind tail-septum; collarette of moderate size; anterior fins tapering, reaching ventral ganglion; hooks 6; posterior teeth 8–12.....**pulchra**
11. Posterior fins longer than anterior fins, or of about same length.....12
12. Posterior fins widest well behind tail-septum, jaws serrated, 6–7 in number.....**serratodentata** group
    a. Posterior fins close to seminal vesicles; seminal vesicles armed with spines anterolaterally, sometimes with a membrane connecting the anterior free end to the body; short space separating caudal fin and seminal vesicle; 12–15 mm. maximum length when mature.....**S.s. pacifica**
    b. Seminal vesicle triangular in shape, anterior border slants posterolaterally; 10–12 mm. maximum length when mature; (common in California current).....**S. pseudoserratodentata**
13. Seminal vesicles close to but not in contact with caudal fin, separated by distance equal to about ½ length of seminal vesicle.....**neglecta**
13. Seminal vesicles touch caudal fin.....14
14. Body very opaque, of uniform width from neck to tail-septum; collarette extends from neck to anterior fins; ovaries extending to neck, containing eggs of moderate size; intestinal diverticula not obvious due to opacity of species.....**robusta**
14. Body moderately transparent, of uniform width from ventral ganglion to tail-septum; ovaries containing large eggs that fill body cavity; intestinal diverticula obvious..**ferox**

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